<u>IN THE SPECIFICATION</u>:

Please amend the specification as follows:

Please substitute the paragraph beginning at page 1, line 27, and ending on page 2, line 12, with the following.

-- Charged-particle-beam exposure apparatuses include a point-beam type which irradiates a spot-like beam, and a variable-rectangular-beam type, which irradiates a beam having a variable rectangular cross section. Regardless of the configuration, the charged-particle-beam exposure apparatus generally comprises an electron gun unit for generating a charged-particle beam, an electron optical system for introducing the beam generated by the electron gun to a sample, a stage system for scanning the entire surface of the sample ~~relatively~~ relative to the electron beam, and an objective deflector for positioning the electron beam on the sample surface with high precision. --

Please substitute the paragraph beginning at page 2, line 13, with the following.

-- A charged-particle beam has an ~~extraordinary~~ extraordinarily high response. Therefore, rather than improving the mechanical and regulatory characteristics of the stage, it is a general procedure to adopt a system that measures an error in the posture and position of the stage and feedbacks the error to positioning of the beam by a deflector which causes a charged-particle beam to scan. --

Please substitute the paragraph beginning at page 2, line 21, and ending on page 3, line 14, with the following.

-- The stage is provided in a vacuum chamber and constrained not to cause magnetic field fluctuation that influences the positioning of a charged-particle beam. For this reason, conventionally, all it that is required is for the stage is to move in a two-dimensional direction. The stage is configured with limited contact-type components, e.g., a rolling guide, a ball screw actuator, or the like. Therefore, the conventional contact-type components raise problems of lubrication and dust generation. To cope with the these problems, the conventional art has proposed a construction shown in Fig. 1, which employs electromagnets (1, 2) as a driving element of the XY stage. Japanese Patent Application Laid-Open No. 11-194824 discloses a non-contact six-degree-of-freedom stage mechanism which employs electromagnet actuators and magnetic shields. The method disclosed in this document allows less fluctuation of leakage flux and assures a highly immaculate environment. Therefore, it is applicable to a positioning apparatus in a vacuum environment and enables highly precise positioning operation. --

Please substitute the paragraph beginning at page 4, line 7, with the following.

-- The present invention has been proposed in view of the conventional problems, and has as its object to provide a positioning apparatus comprising a mechanism for reducing generation of leakage flux. Such a positioning apparatus is realized by simplifying the magnetic shield mechanism. As a result, it is possible to realize weight reduction of a precision-motion substrate

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stage, high acceleration/deceleration of the stage, which mounts the precision-motion substrate stage, and high-speed positioning control. --

Please substitute the paragraph beginning at page 4, line 17, and ending on page 5, line 4, with the following.

-- To solve the above problem, a positioning apparatus according to the present ~~invention,~~ invention mainly has a movable member for transmitting a driving force in a driving-axis direction to a ~~stage;~~ stage, a first electromagnet for driving the movable member in the driving-axis direction by forming a magnetic path between the movable member and the first electromagnet and generating first magnetic ~~flux;~~ flux, and a second electromagnet, which is positioned away from the first electromagnet and arranged in an overlapping direction, for driving the movable member in the driving-axis direction by forming a magnetic path between the movable member and the second electromagnet and generating second magnetic flux having an inverted polarity from the first magnetic flux.--

Please substitute the paragraph beginning at page 5, line 5, with the following.

-- Other features and advantages of the present invention will be apparent from the following ~~descriptions~~ description taken in conjunction with the accompanying drawings, in which like reference characters designate the same or similar parts throughout the figures thereof. --

Please substitute the paragraph beginning at page 7, line 24, and ending on page 8, line 12, with the following.

-- Fig. 2A shows a construction of a one-axis driving mechanism having an electromagnet unit as a driving source. The one-axis driving mechanism shown in Fig. 2A is configured with an I core 200, which is a movable member, and electromagnets 210a, 210b, 210c and 210d. Two of the electromagnets are arranged in each side of the I core in a way to sandwich the I core while maintaining a predetermined gap. The electromagnets 210a, 210b, 210c and 210d are constructed with E cores 220a, 220b, 220c and 220d as well as excitation coils 230a, and so on, which are wound around the E cores. The four electromagnets 210a, 210b, 210c and 210d are arranged as a stationary member 240 ~~with~~ relative to the I core 200, and are integrally connected so as not to make relative movement. --

Please substitute the paragraph beginning at page 10, line 13, and ending on page 11, line 1, with the following.

-- Among the two electromagnets 210a and 210b in the X(+) direction, Fig. 3A shows the magnetic flux generated by the electromagnet 210a arranged in the Z-axis plus direction (Z(+) direction) and Fig. 3B shows the magnetic flux generated by the electromagnet 210b arranged in the Z-axis minus direction (Z(-) direction). The magnetic path is formed from the E cores 220 of the respective electromagnets to the I core 200 through the gap as indicated by the arrows with solid lines. Since currents of inverse directions flow through the excitation coils (230a, 230b) of the electromagnets 210a and 210b, the magnetic flux flowing <u>through</u> the respective magnetic

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paths has inverse directions. Suction power according to the magnetic flux formed in each

magnetic path is generated between the I core 200 and electromagnet 210. --

Please substitute the paragraph beginning at page 11, line 15, with the following.

-- By employing the electromagnets utilizing the effect of magnetic field cancellation as a

driving propulsion source of a one-axis direction, it is possible to construct a one-axis

electromagnet stage which can reduce the leakage flux around the electromagnets. Note that a

specific example of the effect of magnetic field cancellation will be described in the fourth

embodiment, so a description thereof is omitted. --

Please substitute the paragraph beginning at page 13, line 2, with the following.

-- In the above-described construction shown in Fig. 2A, the I core 200 pulled by the two

electromagnets arranged in the X-axis minus direction (X(-) direction) and the two

electromagnets arranged in the X-axis plus direction (X(+) direction) is constructed with a single

common member. However, the I core 200 serving as a movable member does not always have

to be a common member. For instance, as shown in Fig. 4, an I core 401 pulled in the X(-)

direction and an I core 402 pulled in the X(+) direction may be provided, and they may be

integrally connected by an I core supporting member 403 so that the two I cores do not make

have relative movement. The I core supporting member 403 may be formed with a magnetic

material (e.g., a multi-layer steel plate) or a nonmagnetic material. Adopting a lightweight

material as the supporting member 403 enables a reduction in weight of the entire movable

members (401, 402, 403), thus achieving an advantageous construction for high acceleration/deceleration of the stage and high-speed positioning. --

Please substitute the paragraph beginning at page 14, line 7, with the following.

-- Fig. 5 shows a construction using two sets of electromagnet units 570 and 580, which function as a two-axis driving source for translationally driving an I core in the X-axis direction and rotationally driving the I core around the Z axis. Electromagnets 510a to 510h can generate predetermined suction power to drive the I core 500 in the translational direction (e.g., (X(+/-) direction). The two sets of electromagnet units 570 and 580 are arranged away from each other in the Y-axis direction. For instance, when the electromagnet unit 570 pulls the A-end of the I core 500 in the X(+) direction and the electromagnet unit 580 pulls the B-end of the I core 500 in the X(-) direction, it is possible to rotate the I core 500 around the Z axis. --

Please substitute the paragraph beginning at page 15, line 7, with the following.

-- The suction power generated by the electromagnets 510a to 510h is realized by ~~the~~ a̲ similar mechanism to that of the first embodiment described with reference to Figs. 3A to 3C, so a detailed description thereof is omitted. For instance, as shown on the electromagnet 510a, a magnetic path is formed between the E core 520 and I core 500 as indicated by the arrows with the solid lines. Suction power according to the magnetic flux formed in each magnetic path is generated between the I core 500 and electromagnet 510a. --

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Please substitute the paragraph beginning at page 15, line 26, and ending on page 16, line 12, with the following.

-- Taking the electromagnet 510a generating the suction power ~~for~~ as an example, leakage flux such as that shown in Fig. 3A is generated in the external space of the E core 520 and I core 500. However, the leakage flux can be cancelled by the electromagnet 510b arranged in the overlapping direction because the electromagnet 510b forms leakage flux of an inverse polarity and substantially an equal intensity to that of the electromagnet 510a (see Fig. 3B). Accordingly, by employing the electromagnet units utilizing the effect of magnetic field cancellation as a driving propulsion source of a two-axis direction, it is possible to construct a two-axis electromagnet stage which can reduce the leakage flux around the electromagnets. --

Please substitute the paragraph beginning at page 17, line 19, and ending on page 18, line 6, with the following.

-- The suction power generated by the electromagnets is realized by ~~the~~ a similar mechanism to that of the first embodiment described with reference to Figs. 3A to 3C, so a detailed description thereof is omitted. Leakage flux, which is formed when respective electromagnet units generate suction power, can be cancelled by the combination of electromagnets arranged in parallel (overlapped in the Z direction), i.e., 610a and 610b, 610c and 610d, 610e and 610f, 610g and 610h. Accordingly, by employing the electromagnet units utilizing the effect of magnetic field cancellation as a driving propulsion source of a two-axis

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direction, it is possible to construct a two-axis electromagnet stage which can reduce the leakage flux around the electromagnets. --

Please substitute the paragraph beginning at page 18, line 20, and ending on page 19, line 11, with the following.

-- Fig. 7A shows a construction of a precision-motion substrate stage. The precision-motion substrate stage is a six-degree-of-freedom stage capable of moving in an optical axis (Z axis) direction, a translational (X and Y axes) direction, a rotational direction around the Z axis (qz), and a rotational direction (tilt direction) around the X axis and Y axis (qx, qy). A wafer 701 is mounted on a substrate holder 703. As a driving source for moving the stage in the respective directions of the ~~degree~~ degrees of freedom, the above-described electromagnet units are provided for six degrees of freedom. The bottom plate 710a and side plate 710b, mounting the six-degree-of-freedom stage mechanism, functions as a precision-motion XY stage capable of moving in the X and Y directions, which are orthogonal to the optical axis (Z axis). The combination of the bottom plate 710a and side plate 710b will be referred to as a center slider 710c hereinafter. --

Please substitute the paragraph beginning at page 18, line 12, with the following.

-- Assume that the center slider 710c is structured on [[a]] an xy conveyance stage, which is capable of driving on the XY surface at high speed for performing positioning. The wafer is roughly positioned at high speed by the xy conveyance stage, and then precisely positioned by the

precision-motion substrate stage according to this embodiment. Fig. 8 shows how the above-described precision-motion substrate stage is mounted on the stage base 730 and incorporated in the xy conveyance stage. --

Please substitute the paragraph beginning at page 21, line 15, with the following.

-- The precision-motion substrate stage 704 has a cage-like structure to surround the center slider 710c. Opening portions 705 and 717 are provided so that the X movable guide 709 and Y movable guide 719 ~~combined~~ combine to penetrate the opening portions. --

Please substitute the paragraph beginning at page 27, line 10, with the following.

-- The one-axis driving mechanism, shown in Fig. 11A, employing electromagnets as a driving source, is configured with an I core 200, which is a movable member, and electromagnets 210a to 210f. Three of the electromagnets (210a, 210b, 210c and 210d, 210e, 210f) are arranged in each side of the I core in a way to sandwich the I core while maintaining a predetermined gap. The six electromagnets are constructed with six E cores 220a to 220f and excitation coils 230a to 230f, which are wound around the E cores. For instance, the excitation coil 230a is wound around the E core 220a, and the excitation coil 230d is wound around the E core 220d, as shown in Fig. 11A. The six E cores 220a to 220f and excitation coils 230a to 230f are arranged as a stationary member, and are integrally connected so as not to make relative movement. --

Please substitute the paragraph beginning at page 29, line 1, with the following.

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-- The three electromagnets on one side of the I core respectively form magnetic paths from the E cores (220a, 220b, 220c) to the I core 200 through the gap. Among the three electromagnets, only the electromagnet 210b positioned in the center has an opposite current direction. Therefore, the magnetic flux flowing through the magnetic path of the electromagnet 210b has an inverse direction (1120 in Fig. 11B). Accordingly, the distribution of magnetic field leaking in the space around the electromagnet 210b has an opposite direction to that of the electromagnets 210a and 210c. Since the intensity of the magnetic field is proportional to the amount of current, the intensity of the magnetic field of the magnetic flux formed around the electromagnet 210b needs to be twice as high as that of the magnetic flux formed around the electromagnets 210a and 210c. --

Please substitute the paragraph beginning at page 29, line 17, with the following.

-- In other words, assuming that the amount of current (ampere turn) applied by the current control circuit 700 to the electromagnets (210a, 210c) positioned on both ends is [[1]] one, the amount of current applied to the electromagnet 210b is [[2]] two. Therefore, the amount of current is controlled so that currents are applied simultaneously to the three electromagnets arranged in parallel (overlapped in the Z direction) at a ratio of 1:2:1 and an inverse current is applied only to the electromagnet positioned in the center. --

Please substitute the paragraph beginning at page 29, line 27, and ending on page 30, line 12, with the following.

-- Since the excited electromagnets 210a, 210b and 210c are arranged in parallel (overlapping direction) and provided (away from each other) in the same direction, the magnetic flux distributed in the space around the respective electromagnets overlaps one another. The magnetic flux from the electromagnets 210a and 210c positioned on both ends and the magnetic flux from the electromagnet 210b positioned in the center cancel each other, thereby enabling reduction of the overall leakage flux around the three electromagnets. By virtue of the magnetic flux cancellation effect, it is possible to achieve a one-axis electromagnet stage having little leakage flux. --

Please substitute the paragraph beginning at page 31, line 12, with the following.

-- <~~Six~~ Sixth Embodiment (Charged-Particle-Beam Exposure Apparatus)> --

Please substitute the paragraph beginning at page 31, line 14, and ending on page 32, line 15, with the following.

-- Described next is a charged-particle-beam exposure apparatus incorporating a positioning apparatus employing the electromagnets described in the first to fifth embodiments as a driving source. Fig. 12 is a schematic view showing a construction of a charged-particle-beam exposure apparatus. In Fig. 12, numeral 501 denotes an electron gun, which serves as a charged particle source, and includes the cathode, grid, and anode (not shown). An electron source ES irradiated by the electron gun is emitted to an electron optical system 503 through an illumination electron optical system 502. The electron optical system 503 is configured with an aperture

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array, a blanker array, an element electron optical array unit, or the like, which are not shown. The electron optical system 503 forms a plurality of electron source (ES) images. Demagnifying projection is performed on the images by a projection electron optical system 504, thereby forming electron source ES images on a wafer 505 serving as an exposure target surface. A positioning apparatus 508, on which the wafer 505 is placed, is configured with a positioning mechanism 507 and a precision motion mechanism 506. The positioning mechanism 507 performs positioning on the plane by moving in the XY direction. The precision motion mechanism 506 performs more precise positioning with respect to the position determined by the positioning mechanism 507, and adjusts the rotational direction of each axis. --

Please substitute the paragraph beginning at page 33, line 15, with the following.

-- In controlling the linear motor 1312 and electromagnets 610, the stage driving controller 1305 detects the stage position data by a laser interferometer 1313 and ~~feedbacks~~ feeds back the position data to the control loop, thereby driving each actuator (610, 1312) and positioning the wafer 701 to a target exposure position corresponding to the exposure control data. --

Please substitute the paragraph beginning at page 34, line 3, with the following.

-- <Application to a Semiconductor Manufacturing Process> --

Please substitute the paragraph beginning at page 34, line 4, with the following.

-- A semiconductor device manufacturing process (e.g., semiconductor chips, such as an IC or an LSI, CCDs, liquid crystal panels, and the like) employing the above-described charged-particle-beam exposure apparatus is described with reference to Fig. 14. --

Please substitute the paragraph beginning at page 34, line 9, and ending on page 35, line 1, with the following.

-- Fig. 14 shows a flow of an overall semiconductor device manufacturing process. In step 1 (circuit design), a circuit of a semiconductor device is designed. In step 2, exposure control data of the exposure apparatus is generated based on the designed circuit pattern. Meanwhile, in step 3 (wafer production), a wafer is produced with a material such as silicon. In step 4 (wafer process), which is called a pre-process, an actual circuit is formed on the wafer using the mask and wafer by a lithography technique. In step 5 (assembly), which is called a post-process, a semiconductor chip is manufactured using the wafer produced in step 4. Step 5 includes an assembling process (dicing, bonding), a packaging process (chip embedding), and so on. In step 6 (inspection), the semiconductor device manufactured in step 5 is subjected to inspection such as an operation-check test, a durability test, and so on. The semiconductor device, manufactured in the foregoing processes, is shipped (step 7). --

Please substitute the paragraph beginning at page 35, line 2, with the following.

-- The aforementioned wafer process in step 4 includes the following steps: an oxidization step for oxidizing the wafer surface[[;]], a CVD step for depositing an insulating film

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on the wafer surface[[;]], an electrode forming step for depositing electrodes on the wafer[[;]], an ion implantation step for implanting ~~ion~~ ions on the wafer[[;]], a resist-process step for coating a photosensitive agent on the wafer[[;]], an exposure step for exposing the circuit pattern on the wafer by the above-described exposure apparatus[[;]], a developing step for developing the exposed wafer[[;]], an etching step for removing portions other than the developed resist image[[;]], and a resist separation step for removing the unnecessary resist after the etching process. By repeating the foregoing steps, multiple circuit patterns are formed on the wafer. --

Please substitute the paragraph beginning at page 35, line 18, with the following.

-- By employing the above-described charged-particle-beam exposure apparatus, it is possible to achieve high precision in exposure operation and improved throughput of the apparatus. Therefore, the productivity of semiconductor devices can be ~~more~~ improved more than ~~the~~ by using conventional productivity techniques. --

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